

METHOD AND APPARATUS FOR RESIN-SEALING ELECTRONIC COMPONENTS

[TECHNICAL FIELD]

5 [0001]

The invention relates to an improved resin-sealing method for resin-sealing and molding small electronic components, such as semiconductor chips mounted on lead frames and semiconductor substrates, with resin materials and a resin-sealing apparatus for electronic components for use in performing the
10 method.

The invention more particularly relates to a method for resin-sealing electronic components improved by effectively preventing the following problems that may occur during the process of resin-sealing an electronic component on an unsealed substrate located in a cavity of resin-sealing dies; failure to fill a cavity
15 with resin, voids formed inside and/or outside of a resin package, and leakage of resin through an air vent by which inside and outside of the cavity communicate with each other.

The invention further relates to a structurally simplified resin-sealing apparatus for use in performing the improved method.

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[BACKGROUND ART]

[0002]

For instance, the flip-chip bonding is a conventional technique that electrically interconnects a substrate (semiconductor substrate) and a chip
25 (semiconductor chip) with bulging terminals (bumps). This technique mostly fills an interval between the bump-connected substrate and chip with a liquid sealing material (underfill material). In recent years, the development of a technique, generally called mold underfill, is underway to reduce assembling costs. This technique, in combination with transfer molding, fills the substrate-
30 chip interval with a liquid sealing material. In order to efficiently and unfaillingly fill the substrate-chip interval with the liquid sealing material, the

mold underfill needs high-fluidity resin materials containing ultraparticulate fillers (ultra low-viscosity resins).

[0003]

The mold underfill has some technical issues to be addressed. One of them is leakage of resin through the air vent. The resin material used in this technique has high fluidity, and a certain resin pressure is applied to the resin material in the cavity during the resin molding. Due to these factors, the resin material in the cavity is likely to flow out of the air vent.

Only to serve the purpose of preventing the resin from leaking therethrough, the air vent may preferably have a shallower groove. Such an air vent, however, loses the function to release residual air remaining in the cavity to outside. This often leads to other problems. For example, it remains unaccomplished to eliminate risks of voids (air bubbles) and defective parts inside and/or outside of a resin-sealed mold (resin package) formed in the cavity.

[0004]

To solve the problems, the applicant of this patent application provides a structure in which air vent pin fitting plates with an air vent pin fitted therein are stacked on one another at a position in a direction in which resin-sealing dies are opened and closed that is a position overlapping a molded article ejector mechanism, so that the air vent pin is located in an air vent groove. With the air vent groove being left open via the air vent pin, injection of a resin material into a cavity and reduction of an internal pressure of the cavity are performed. Then, the air vent groove is closed with the air vent pin when the injection of the resin material into the cavity is completed. As a result, leakage of the resin through the air vent groove is prevented without undermining the intended function of the air vent during the resin-sealing and molding an electronic component (Patent Document 1).

[0005]

The invention described in the Patent Document 1 has the following advantages. The invention, when applied to the resin-seal molding using a high-fluidity resin material, can eliminate the risk of voids formed inside of the

resin-sealed mold by efficiently releasing residual air remaining in the cavity to outside.

The invention, wherein the high-fluidity resin material can be handled well, reliably and efficiently fills a chip-substrate interval with a liquid sealing material during the flip-chip bonding, thereby actualizing the mold underfill in combination with transfer molding.

The invention prevents that the high-fluidity melted resin material injected into the cavity flows out of there through the air vent groove.

[0006]

As described in the Cited Document 1, the air vent pin fitting plates with the air vent pin fitted therein are stacked on one another at a position in the die opening/closing direction that overlaps the molded article ejector mechanism, and the air vent pin is fitted in the air vent groove. This is rather a complicated structure, naturally resulting in a complicated operation.

[PRIOR ART DOCUMENT]

[PATENT DOCUMENT]

[0007]

[PATENT DOCUMENT 1] Japanese Patent Application Laid-Open 2013-049253 (see [0030], and Fig. 4)

[SUMMARY OF THE INVENTION]

[PROBLEMS TO BE SOLVED BY THE INVENTION]

[0008]

As a result of improvements of the disclosed structure, this invention is directed at reducing overall production costs of a resin-sealing apparatus and simplifying maintenance work for the apparatus by employing a facilitated resin-sealing method and a simplified molding die structure to handle a high-fluidity resin material.

[SOLUTIONS TO THE PROBLEMS]

[0009]

A resin-sealing method for an electronic component according to the invention includes:

a resin-sealing apparatus-preparing step for preparing a resin-sealing apparatus for an electronic component, the apparatus including: dies for the electronic component, the dies having at least a stationary die (upper die 5) and a movable die (lower die 8) facing the stationary die (upper die 5), the movable die being allowed to move toward and away from the stationary die by a die opening/closing mechanism 9; a cavity block 16 disposed on a die surface of the stationary die in a manner that is allowed to move along a die opening/closing direction by a floating mechanism having an elastic member (floating pin 18); a cavity 20 and an air vent groove 22 connected to and communicating with the cavity 20 and formed on a die surface of the cavity block 16; a fit-in hole 24 formed in a connected portion of the cavity 20 and the air vent groove 22 along the die opening/closing direction; and an air vent block 23 disposed on a portion of the stationary die (floating pin holder 17) corresponding to the fit-in hole 24 along the die opening/closing direction, the air vent block 23 being slidably and closely fitted in the fit-in hole 24, the method further including:

an unsealed substrate-feeding step for transporting an unsealed substrate W with the electronic component to between the stationary die and the movable die (5, 8) to feed the unsealed substrate W into a substrate feeding portion 26 of the movable die;

a resin material-feeding step for feeding a high-fluidity resin material (ultra low-viscosity resin) R into a resin-feeding portion of the movable die (into a pot 10a);

a first die-closing step for joining a die surface of the movable die to the die surface of the stationary die using the die opening/closing mechanism 9, the first die-closing step being performed subsequent to the unsealed substrate-feeding step and the resin material-feeding step;

an inter-die space pressure-reducing step for reducing a pressure in an inter-die space between the die surfaces of the stationary die and the movable

die, the inter-die space pressure-reducing step being performed during the first die-closing step;

a melted resin material-pressurizing/transferring step for heating and melting the resin material R in the resin feeding portion (in the pot 10a) while the inter-die space pressure-reducing step is maintaining the reduced pressure in the inter-die space, the melted resin material-pressurizing/transferring step further transferring the melted resin material R under a pressure into the cavity 20 through a resin passage (cull 19 and gate 21) in the inter-die space;

a second die-closing step for moving (upward) the cavity block 16 of the stationary die against elasticity of the elastic member (floating pin 18) of the floating mechanism;

an air vent block-moving step for relatively moving (downward) the air vent block 23 to align an edge surface (lower surface 23a) of the air vent block 23 and the die surface of the cavity block 16 to be flush with each other, the air vent block-moving step being performed during the second die-closing step;

a cavity sealing step for pressing the edge surface of the air vent block 23 against a surface (upper surface) of a wiring board of the unsealed substrate W to be joined to the edge surface of the air vent block 23 in the substrate feeding portion 26 thereby to seal the cavity 20 of the cavity block 16, the cavity sealing step being performed during the air vent block moving step;

a resin-molding step (transfer molding step) for further transferring the melted resin material under a pressure into the cavity 20 to fill the cavity 20 with the melted resin material, the resin-molding step being performed subsequent to the cavity-sealing step; and

a molded article-removing step for opening the stationary die and the movable die using the die opening/closing mechanism 9 to remove a molded article (resin-sealed substrate W1) solidified and molded in the cavity 20 and the resin passage, the molded article-removing step being performed subsequent to the resin-molding step.

[0010]

A resin-sealing apparatus for an electronic component according to the

invention includes:

dies for resin-sealing the electronic component, the dies having at least a stationary die (upper die 5) and a movable die (lower die 8) facing the stationary die (upper die 5), the movable die (lower die 8) being allowed to move toward and
5 away from the stationary die (upper die 5) by a die opening/closing mechanism 9;

a cavity block 16 disposed on a die surface of the stationary (upper die 5) die in a manner that is allowed to move along a die opening/closing direction by a floating mechanism having an elastic member (floating pin 18);

a cavity 20 and an air vent groove 22 connected to and communicating
10 with the cavity 20 and formed on a die surface of the cavity block 16;

a fit-in hole 24 formed in a connected portion of the cavity 20 and the air vent groove 22 along the die opening/closing direction; and

an air vent block 23 disposed on a portion of the stationary die (floating pin holder 17) corresponding to the fit-in hole 24 along the die opening/closing
15 direction, the air vent block 23 being slidably and closely fitted in the fit-in hole 24.

[0011]

A resin-sealing apparatus for an electronic component according to the invention includes:

20 dies for resin-sealing the electronic component, the dies having at least a stationary die (upper die 5) and a movable die (lower die 8) facing the stationary die (upper die 5), the movable die (lower die 8) being allowed to move toward and away from the stationary die (upper die 5) by a die opening/closing mechanism 9;

a cull block 15 and a first cavity block 16 formed in a die surface of the
25 stationary die in a manner that are allowed to move along a die opening/closing direction by a floating mechanism having an elastic member (floating pin 18);

a cull 19 serving as a resin flow divider and disposed on a die surface of the cull block 15;

a gate 21 connected to and communicating with the cull 19, a cavity 20
30 connected to and communicating with the gate 21, and an air vent groove 22 connected to and communicating with the cavity 20 that are disposed on a die

surface of the first cavity block 16;

a fit-in hole 24 formed in a connected portion of the cavity 20 and the air vent groove 22 along the die opening/closing direction; and

an air vent block 23 disposed on a portion of the stationary die (floating pin holder 17) corresponding to the fit-in hole 24 along the die opening/closing direction, the air vent block 23 being slidably and closely fitted in the fit-in hole 24;

a pot block 10 having a resin feeding portion (pot 10a) for feeding a resin material R and disposed in a portion of the movable die (lower die 8) facing the stationary die (upper die 5);

a side block 11 disposed at a position on a lateral side of the pot block 10;

a second cavity block 12 attached to a die surface of the side block 11, the second cavity block 12 being allowed to move along the die opening/closing direction by a floating mechanism having an elastic member 14; and

an inter-die pressure-reducing mechanism for reducing a pressure in an inter-die space between the die surface of the stationary die (upper die 5) and a die surface of the movable die (lower die 8) during a first die-closing step for joining the die surfaces of the stationary die and the movable die using the die opening/closing mechanism 9, wherein

in a second die-closing step for pressing, in addition to the first die-closing step, the die surfaces of the stationary die (upper die 5) and the movable die (lower die 8) toward each other against elasticity of the floating mechanism using the die opening/closing mechanism 9, at least an edge surface (lower surface 23a) of the air vent block 23 arrives at a position flush with a parting line P.L plane as a result of relative movement of the air vent block 23.

[EFFECTS OF THE INVENTION]

[0012]

The invention, while using the high-fluidity resin material R for sealing and molding electronic components, can succeed in releasing residual air remaining in the cavity 20 to outside.

This remarkable advantage unfailingly avoids that voids and/or defective parts inside and/or outside of the resin package 29 formed integral with the resin-sealed substrate W1.

[0013]

5 The air vent block 23 securely fixed to the side of the apparatus with the upper die plate 4 constitutes a part of the cavity 20 and a seal member for sealing the cavity 20 during the step of closing the upper and lower dies 5 and 8.

During the step of closing the upper and lower dies 5 and 8, the cavity-sealing step is performed so as to prevent the high-fluidity melted resin material injected
10 into the cavity 20 from flowing out of there through the air vent groove 22.

It is, therefore, unnecessary to install any complicated die structure, for example, a dedicated drive mechanism that moves the air vent block 23 upward and downward in order to open and close the air vent groove.

Thus, high-fluidity resin materials can be handled well with such a
15 facilitated resin-molding method and simplified die structure. Other advantages are: reduction of overall production costs of such a resin-sealing apparatus, and simplified maintenance work for the apparatus.

[BRIEF DESCRIPTION OF THE DRAWINGS]

20 [0014]

Fig. 1 is a schematic front view of a resin-sealing apparatus according to the invention used in combination with transfer molding, illustrating upper and lower dies that are opened.

25 Figs. 2 are schematic front sectional views of the resin-sealing apparatus illustrated in Fig. 1, wherein Fig. 2 (1) illustrates semiconductor molding dies that are opened, Fig. 2 (2) illustrates a first die-closing state, and Fig. 2 (3) illustrates a second die-closing state.

Fig. 3 is an enlarged longitudinal sectional view of a principal portion of the semiconductor molding dies illustrated in Fig. 2 (1).

30 Fig. 4 (1) is an enlarged longitudinal sectional view of a principal portion of the semiconductor molding dies illustrated in Fig. 2 (2), and Fig. 4 (2) is a

further enlarged longitudinal sectional view of the principal portion.

Fig. 5 (1) is an enlarged longitudinal sectional view of a principal portion of the semiconductor molding dies illustrated in Fig2 (3), and Fig. 5 (2) is a further enlarged longitudinal sectional view of the principal portion.

5 Figs. 6 (1) and (2) are explanatory drawings of an action exerted by a floating pin.

Fig. 7 is a longitudinal sectional view of the semiconductor molding dies illustrated in Fig. 3, illustrating a molded article ejected to between upper and lower dies.

10 [Embodiments of the invention]

[0015]

The invention is hereinafter described referring to the accompanying drawings.

15 [0016]

Fig. 1 schematically illustrates the whole structure of a resin-sealing apparatus according to the invention used in combination with, generally called, transfer-molding means.

The resin-sealing apparatus has a base 1 of the apparatus, tie bars 2 standing upright on the base 1, a stationary plate 3 mounted on upper ends of the tie bars 2, an upper die plate 4 mounted on a lower section of the stationary plate 3, an upper die 5 (stationary die) for resin-molding attached to a lower section of the upper die plate 4, a movable plate 6 fitted in the tie bars 2 at positions down below the upper die 5, a lower die plate 7 mounted on an upper section of the movable plate 6, a lower die 8 (movable die) for resin-molding attached to an upper section of the lower die plate 7, and a die opening/closing mechanism 9, such as a servo motor, configured to move the movable plate 6 upward and downward to join or separate opposing die surfaces of the upper and lower dies 5 and 8.

30 [0017]

The resin-sealing apparatus has resin-sealing dies for electronic

components including at least the upper die 5 (stationary die) and the lower die 8 (movable die) facing the upper die 5. The resin-sealing dies are allowed to open and close relative to each other when the lower die 8 is moved toward and away from the upper die 5 by the die opening/closing mechanism 9.

5 [0018]

A pot block 10 is installed in a portion at the center of the lower die 8, and a plunger 13 for applying a pressure to resin is fitted in the pot block 10.

[0019]

10 Lower die cavity blocks 12 (second cavity blocks) are fitted in die surfaces of side blocks 11 at positions on left and right of the pot block 10 in a manner that are allowed to move upward and downward.

The lower die cavity block 12 has a floating mechanism (floating structure) that generates an elastic pressing force exerted upward by elasticity of elastic members 14. The lower die cavity block 12 is accordingly allowed to
15 move by the floating mechanism in a direction in which the dies are opened and closed. As described later, a space in the upper direction of the lower die cavity block 12 is a substrate-feeding portion 26.

[0020]

A cull block 15 is disposed on the die surface (lower surface) of the upper
20 die 5 opposite to the position of the pot block 10 in the lower die 8. Upper die cavity blocks 16 (first cavity blocks) are disposed in portions of the die surface of the upper die 5 opposite to the lower die cavity blocks 12 of the lower die 8.

[0021]

The cull block 15 and the upper cavity blocks 16 are supported with
25 respect to the upper die plate 4 by a plurality of floating pins 18. A floating pin holder 17 is mounted on the floating pins 18. The floating pin holder 17 is located between the upper die plate 4 and upper surfaces of the cull block 15 and the upper die cavity blocks 16. According to this embodiment, the floating mechanism includes the floating pins 18 which are elastic members. The cull
30 block 15 and the upper die cavity blocks 16 are disposed on the die surface of the upper die 5 (stationary die) in a manner that are allowed to move along the die

opening/closing direction by the floating mechanism.

[0022]

A cull 19 is formed on a lower surface (die surface) of the cull block 19 as a resin flow divider that divides the flow of a melted resin material.

5 [0023]

Cavities 20 for resin-molding are formed on the die surfaces of the upper die cavity blocks 16.

[0024]

10 In portions of the upper die cavity blocks 16 respectively connected to the cull 19, gates 21 are formed in narrower widths toward the cavities 20. These gates 21 are inlets for the melted resin material to flow into the cavities 20.

[0025]

15 Air vent grooves 22 connected to the cavities 20 are formed in a required depth in the die surfaces of the cavity blocks 16 located on the opposite side of the gates 21.

[0026]

20 As described so far, the following structural elements are formed on the die surface of each cavity block 16; the gate 21 connected to and communicating with the cull 19, the cavity 20 connected to and communicating with the gate 21, and the air vent groove 22 connected to and communicating with the cavity 20.

[0027]

25 In each of the upper die cavity blocks 16, a fit-in hole 24 is formed in a portion connected to the cavity 20 and the air vent groove 22. The fit-in hole 24 is a hole for the air vent block 23 to be fitted in. The connected portion described above is the destination of the melted resin material flowing into the cavity 20 through the gate 21. The fit-in hole 24 is formed along the die opening/closing direction, and the air vent block 23 is fitted in the fit-in hole 24 slidably and closely (in close contact with the fit-in hole). The air vent blocks 23 are securely
30 fixed to the lower surface of the floating pin holder 17, which belongs to the upper die 5 (stationary die), along the die opening/closing direction. The air vent

blocks 23, though securely fixed to the upper die plate 4 through the floating pin holder 17, move downward relative to the upper die cavity blocks 16 of the upper die 5 when the upper die 5 is pushed upward against elasticity of the floating pins 18 at the time of closing the upper and lower dies 5 and 8 as described later.

5 [0028]

The air vent block 23 is allowed to downwardly move relative to the upper die cavity block 16. The movements of the respective units are configured so that a lower surface 23a of the air vent block 23 is flush with a parting line P.L plane at the time of joining the upper surfaces of the cull block 15 and the upper die cavity block 16 to the lower surface of the floating pin holder 17 (see Figs. 5).
10 [0029]

Referring to the drawings, the surface of the air vent block 23 joined to the cavity has a resin filling portion 23b constituting a part of the cavity 20. The resin filling portion 23b is a recess rectangular in cross section. The movements of the respective units are configured so that ceiling surfaces of the resin filling portion 23b and the cavity 20 are flush with each other when the lower surface 23a of the air vent block 23 is flush with the parting line P.L plane (Figs. 5).
15 [0030]

A draft angle (not illustrated in the drawings) may be provided for the cavity 20 including the resin filling portion 23b of the air vent block 2, so that the molded article is readily removed from the dies.
20 [0031]

The air vent block 23 may not be necessary to have the resin filling portion 23b. As an alternative option, the cavity 20 with a predetermined capacity may be formed in the upper die cavity block 16, and the air vent blocks 23, instead of constituting a part of the cavity 20, may be equipped with two functions alone; an air ventilating function, and a resin leakage preventing function to prevent leakage of the resin from the cavity 20. These functions will
25
30 be described later.
[0032]

A vacuum pump (not illustrated in the drawings) is connected to the air vent groove 22 with an appropriate air suctioning path 25 interposed therebetween. The resin-sealing apparatus has an inter-die pressure-reducing mechanism including the vacuum pump. By actuating the vacuum pump at the time of closing the upper and lower dies 5 and 8, the inter-die pressure-reducing mechanism reduces an internal pressure of the cavity 20 through the air suctioning path 25 and the air vent groove 22.

[0033]

The lower die 8 is structurally characterized as described below. The pot block 10 having the resin-feeding pot 10a (resin feeding portion) is formed in a portion of the lower die 8 opposite to the cull block 15 of the upper die 5. The resin pressure-applying plunger 13 is fitted in the pot 10a.

[0034]

On the die surface of the lower die 8 opposite to the cavity 20 in the die surface of the upper die 5, there is the substrate feeding portion 26 on which an unsealed substrate W is to be put. The lower die cavity block 12 is fitted in the lower die 8 movably upward and downward at a position opposite to the position of the cavity 20 formed in the die surface of the upper die 5. The lower die cavity block 12 is fitted in between the pot block 10 and the side block 11. The lower die cavity block 12 has a floating mechanism. The floating mechanism has elastic members 14, such as compression springs or cone disc springs, interposed between the lower surface of the lower die cavity block 12 and the lower die plate 7. The floating mechanism generates an elastic pressing force exerted upward by elastically energizing the elastic members 14. An upper space defined by the upper surface of the lower die cavity block 12 and the side surfaces of the pot block 10 and the side block 11 constitutes the substrate feeding portion 26 (see Fig. 3).

[0035]

The unsealed substrate W described in this example as an example of the unsealed substrate includes a wiring board 27a, and a semiconductor chip 27c mounted on the wiring board 27a with solder bumps 27b.

[0036]

The cull 19 of the cull block 15 and the gate 21 of the upper die cavity block 16 constitute a resin passage for transferring the resin material heated and melted in the pot 10a of the pot block 10 into the cavity 20 during a first die closing stage illustrated in Figs. 2 (2) and 4. During the first die closing stage, the pot 10a, cull 19, gate 21, cavity 20, fit-in hole 24, and air suctioning path 25 constitute an inter-die space between the die surfaces of the upper and lower dies 5 and 8 through which air can be ventilated.

[0037]

Next is described in detail a positional relationship between the upper die 5 and the air vent block 23 at the time of opening the upper and lower dies 5 and 8 as illustrated in Fig. 1. The upper and lower dies 5 and 8 are opened by moving the lower die 8 downward using the die opening/closing mechanism 9. More specifically, between the distantly spaced die surfaces of the upper and lower dies 5 and 8 as illustrated in Fig. 1, the upper die 5, specifically, the cull block 15 and the upper die cavity block 16 are moved downward toward the lower die 8 by the elastically energized floating pins 18 and stops at a predetermined vertical position (see Fig. 3). On the other hand, the air vent block 23, which is securely fixed to the upper die plate 4 by means of the floating pin holder 17, is not allowed to move downward. As a result of the downward movements of the cull block 15 and the upper die cavity block 16, however, the air vent block 23 is relatively moved upward.

[0038]

Hereinafter, a description is given to a method for resin-sealing an electronic component using the resin-sealing apparatus described so far. At the time of opening the upper and lower dies 5 and 8, the unsealed substrate W with an electronic component mounted thereon is transported to between the upper and lower dies by a suitable carry-in loader (not illustrated in the drawings) and put on the substrate feeding portion 26 of the lower die 8. Further, a high-fluidity resin material (ultra low-viscosity resin) R is fed into the pot 10a of the lower die 8 (see Fig. 3).

After these steps of feeding the unsealed substrate and feeding the resin material, the lower die plate 7 and the lower die 8 are moved upward by the die opening/closing mechanism 9 to close the dies (see Fig. 1).

[0039]

5 The die closing starts with a first die-closing step, in which the lower die 8 is moved upward to join the die surface (upper surface) of the lower die 8 to the die surface (lower surface) of the upper die 5 (see Fig. 2 (2)). Subsequent to the first die-closing step, the die surfaces (upper surfaces) of the pot block 10 and the side block 11 of the lower die 8 are joined to the die surfaces (lower surfaces) of the cull block 15 and the upper die cavity block 16 of the upper die 5 (see Fig. 2 (2)). As illustrated in the enlarged view of Fig. 4 (1), the floating pins 18 are yet to be elastically deformed, and an interval S accordingly remains, allowing the cull block 15 and the upper die cavity block 16 to move upward. Therefore, the air vent block 23 securely fixed to the upper die plate 4 by the floating pin holder 15 17 still maintains the same vertical position, ensuring ventilation of air between the lower surface 23a of the air vent block 23 and the die surface of the upper die cavity block 16 (parting line P.L plane). At the time, the wiring board 27a of the unsealed substrate W in the substrate feeding portion 26 is pushed upward by the lower die cavity block 12 to which the elastic pressing force is applied by the 20 elastic members 14. The upper surface of wiring board 27a is accordingly closely joined to the die surface of the cavity 20 of the upper die cavity block 16.

[0040]

During the first die-closing step, air can be ventilated through the inter-die space between the die surfaces of the upper and lower dies 5 and 8, specifically, the pot 10a, cull 19, gate 21, cavity 20, fit-in hole 24, and air suctioning path 25. Then, an inter-die space pressure-reducing step is performed, in which the pressure in the inter-die space is reduced by driving the vacuum pump (not illustrated in the drawings) of the inter-die pressure-reducing mechanism.

30 [0041]

The resin material R in the pot 10a of the lower die 8 is heated and

melted by resin-heating means (not illustrated in the drawings) installed in the upper and lower dies 5 and 8. Further, the melted resin material, while being pressurized by the cull 19 located upward under a pressurizing force exerted by the plunger 13, is injected into the cavity 20 through the gate 21. This is a melted resin material-pressurizing/transferring step in which the pressure is pressurized by the plunger 13. This step is performed either after or in combination with the pressure-reducing step. After the pressure reduction in the inter-die space, the melted resin material-pressurizing/transferring step is performed, so that residual air remaining in the inter-die space and combustion gases generated during the heating and melting the resin material R are forced out of the inter-die space.

[0042]

The inter-die space pressure-reducing step may be performed continuously during the first die-closing step until a second die-closing step starts. The second die-closing step will be described later.

[0043]

The first die-closing step may be followed by the second die-closing step, in which the lower die 8 is further moved upward by the die opening/closing mechanism 9 against the elasticity of the floating pins 18, so that the upper surfaces of the cull block 15 and the upper die cavity blocks 16 are joined to the lower surface of the floating pin holder 17. When the second die-closing step is over, there is practically no longer the interval S. The relative vertical position of the air vent block 23 securely fixed to the upper die plate 4 by the floating pin holder 17, accordingly changes. Then, an air vent block-moving step is performed, in which vertical positions of the lower surface 23a (edge surface) of the air vent block 23 and the die surface (P.L plane) of the upper die cavity block 16 are aligned to be flush with each other, and vertical positions of ceiling surfaces of the cavity 20 and the resin filling portion 23b of the air vent block 23 are aligned to be flush with each other (see Fig. 5).

By performing this air vent block-moving step, the air vent block 23 and the upper die cavity block 16 are fitted into each other. This fitting step is

performed so that the ceiling surfaces of the resin filling portion 23b and the cavity 20 are flush with each other at least when the vertical position of the lower surface 23a of the air vent block is flush with the parting line P.L plane.

Further, the lower surface 23a of the air vent block 23 and the upper surface of the wiring board 27a joined to the lower surface 23a are subject to a force that maintains the relative downward movement of the air vent block 23 and also subject to the elastic push-up force exerted by the elastic members 14.

Therefore, the lower surface 23a of the air vent block 23 and the upper surface of the wiring board 27a are pressed against each other. Pressing these surfaces against each other is a cavity-sealing step. As a result of this step, the cavity 20 and the air vent groove 22 are practically isolated from each other.

[0044]

During the second die-closing step, the floating pin 18 is elastically deformed as schematically illustrated in Figs. 6. As illustrated in Fig. 6 (1), the interval S is defined between the floating pin holder 17 and the cull block 15 so that the cull block 15 and the upper die cavity block 16 are allowed to move upward to open the upper and lower dies 5 and 8, and also to close the dies during the first die-closing step later. When the upper surfaces of the cull block 15 and the upper die cavity block 16 are joined to the lower surface of the floating pin holder 17 during the second die-closing step as illustrated in Fig. 6 (2), floating pin 18 is deformed, and there is no longer the interval S.

During the second die-closing step, the floating pin 18, under a die closing pressure exerted by the upper and lower dies 5 and 8, is elastically deformed to be vertically smaller in its axial direction, and then inserted in a pin holder hole 17a of the floating pin holder 17.

During the first die-closing step or when the upper and lower dies 5 and 8 are opened, the die closing pressure is no longer exerted by the upper and lower dies 5 and 8, and the floating pin 18 resumes its original shape. Then, the cull block 15 and the upper die cavity block 16 are allowed to move downward to their originally intended positions illustrated in Fig. 6 (1).

[0045]

The drawings illustrate the floating mechanism having floating pins 18 with a required elasticity. Instead, other options, for example, a floating mechanism with elastic members such as compression springs or cone disc springs, can obviously obtain similar operational advantages.

5 [0046]

Subsequent to the cavity-sealing step, a resin-molding step (transfer molding step) is performed, in which the melted resin material in the pot 10a is subject to a further pressure exerted by the plunger 13 to be transferred and filled into the cavity 20.

10 [0047]

During the resin-molding step, the melted resin material R (hereinafter, melted resin material), being subject to a pressure applied by the plunger 13, is injected into the cavity 20 through the resin passage (cull 19, gate 21). Then, the melted resin material is injected into the resin filling portion 23b of the air vent block 23 which is the destination of the melted resin material in the final stage. The lower surface 23a of the air vent block 23 and the upper surface of the wiring board 27a have already been sealed in the cavity-sealing step. This effectively prevents that the melted resin material filled in the cavity 20 and the resin filling portion 23b of the air vent block 23 leaks out of the sealed portion through the air vent groove 22.

As described earlier, the reduced pressure is kept in the resin filling portion 23b which is the destination of the melted resin material in the final stage. This prevents such a damaging event that residual air infiltrates into the melted resin material filled in this portion.

25 Assuming that there is a trace amount of air remaining in this portion, a predetermined resin pressure applied by the plunger 13 effectively prevents possible formation of voids.

[0048]

A molded article-removing step is performed as described below to remove the resin-sealed substrate (molded article) W1 solidified and molded in the cavity 20 and the resin passage. A first die-opening step is performed to

open the dies 5 and 8 closed by the first die-closing step of Fig. 2 (2), in which the lower die 8 is moved downward by the die opening/closing mechanism 9. Then, a second die-opening step is performed to open the dies again as illustrated in Fig. 2 (1). The molded article-removing step is performed with the dies being
5 opened to transport the resin-sealed substrate W1 out of the apparatus using a carry-out loader (not illustrated in the drawings).

[0049]

As illustrated in Fig. 7, the resin-sealed substrate W1 removed from between the upper and lower dies 5 and 8 has a solid mold 28 and a resin
10 package 29 formed integral with each other, wherein the solid mold 28 has a shape corresponding to the resin passage (cull 19, gate 21), and the resin package 29 has a shape corresponding to the cavity 20 and the resin filling portion 23b of the air vent block. The resin package 29 is molded with the high-fluidity resin material R. Thus, mold-underfilling is performed, in which the melted resin
15 material is smoothly filled in a connected portion 30 between the wiring board 27a and the semiconductor chip 27c. The connected portion 30 is hence protected by the resin thus filled in the interval between the wiring board 27a and the semiconductor chip 27c which is flip-chip bonded with solder bumps 27b, thereby improving the reliability of the molded article.

20 [0050]

According to this example, residual air remaining in the cavity 20 can be efficiently released to outside in the case of molding electronic components using the high-fluidity resin material R. This effectively prevents possible formation of defective parts and/or voids inside and outside of the resin package 29 formed
25 integral with the resin-sealed substrate W1, and that the high-fluidity melted resin material injected into the cavity 20 flows out of there through the air vent groove 22.

[0051]

The air vent block 23 is securely fixed to the upper die plate 4 to allow
30 the air vent block 23 to also serve as a part of the cavity 20 and the seal member used to seal the cavity 20 at the time of closing the upper and lower dies 5 and 8.

In the first and second die-closing steps in which the upper and lower dies 5 and 8 are closed, the cavity-sealing step is performed to effectively prevent that the high-fluidity melted resin material injected into the cavity 20 flows out of there through the air vent groove 22. This eliminates the need to additionally install any complicated structure, for example, a dedicated drive mechanism that moves the air vent block 23 upward and downward in order to open and close the air vent groove 22. Therefore, high-fluidity resin materials can be handled well with the resin-sealing method and die structure that are facilitated and simplified as compared to the prior art. At the same time, overall production costs of the resin-sealing apparatus can be reduced, and maintenance work for the apparatus can be simplified. This invention provides such remarkable advantages in practical use.

[0052]

Instead of the dies including the upper and lower dies 5 and 8 illustrated in the examples, the apparatus may have upper and lower dies functionally reversed.

[0053]

The invention is not limited to the examples described so far. The technical features described thus far may be optionally and suitably changed or selected, if necessary, within the spirit and scope of this invention.

[0054]

The resin material according to the invention may be any one of thermosetting resin materials and thermoplastic resin materials. The resin material according to the invention may be prepared in the form of liquid, powder, granules, or tablets.

[0055]

The high-fluidity resin material according to the invention may be selected from, for example, ultra low-viscosity resins. Such ultra low-viscosity resins are in the form of liquid or solid at normal temperature but are melted, highly fluidized, and very low in viscosity when heated.

[DESCRIPTION OF REFERENCE SYMBOLS]

[0056]

	1	base
	2	tie bar
5	3	stationary plate
	4	upper die plate
	5	upper die
	6	movable plate
	7	lower die plate
10	8	lower die
	9	die opening/closing mechanism
	10	pot block
	10a	pot
	11	side block
15	12	lower die cavity block (second cavity block)
	13	plunger
	14	elastic member
	15	cull block
	16	upper die cavity block (first cavity block)
20	17	floating pin holder
	18	floating pin
	19	cull
	20	cavity
	21	gate
25	22	air vent groove
	23	air vent block
	23a	lower surface of air vent block
	23b	resin filling portion
	24	fit-in hole
30	25	air suctioning path
	26	substrate feeding portion

	27a	wiring board
	27b	solder bump
	27c	semiconductor chip
	28	solid mold
5	29	resin package
	30	connected portion
	R	resin material
	S	interval
	W	unsealed substrate
10	W1	resin-sealed substrate
	P.L	parting line

Claims

1. A method for resin-sealing an electronic component, comprising:
a resin-sealing apparatus-preparing step for preparing an apparatus for resin-sealing an electronic component, the apparatus comprising:

5 dies for resin-sealing the electronic component, the dies having at least a stationary die and a movable die facing the stationary die, the movable die being allowed to move toward and away from the stationary die by a die opening/closing mechanism;

a cavity block disposed on a die surface of the stationary die in a manner
10 that is allowed to move along a die opening/closing direction by a floating mechanism having an elastic member;

a cavity and an air vent groove connected to and communicating with the cavity and formed on a die surface of the cavity block;

a fit-in hole formed in a connected portion of the cavity and the air vent
15 groove along the die opening/closing direction; and

an air vent block disposed on a portion of the stationary die corresponding to the fit-in hole along the die opening/closing direction, the air vent block being slidably and closely fitted in the fit-in hole,

the method further including:

20 an unsealed substrate-feeding step for transporting an unsealed substrate mounted with the electronic component to between the stationary die and the movable die to feed the unsealed substrate into a substrate feeding portion of the movable die;

a resin material-feeding step for feeding a high-fluidity resin material
25 into a resin feeding portion of the movable die;

a first die-closing step for joining a die surface of the movable die to the die surface of the stationary die using the die opening/closing mechanism, the first die-closing step being performed subsequent to the unsealed substrate feeding step and the resin material-feeding step;

30 an inter-die space pressure-reducing step for reducing a pressure in an inter-die space between the die surfaces of the stationary die and the movable

die, the inter-die space pressure-reducing step being performed during the first die-closing step;

a melted resin material-pressurizing/transferring step for heating and melting the resin material in the resin feeding portion while the inter-die space pressure-reducing step is maintaining the reduced pressure in the inter-die space, the melted resin material-pressurizing/transferring step further transferring the melted resin material under a pressure into the cavity through a resin passage in the inter-die space;

a second die-closing step for moving the cavity block of the stationary die against elasticity of the elastic member of the floating mechanism;

an air vent block-moving step for relatively moving the air vent block to align an edge surface of the air vent block and the die surface of the cavity block to be flush with each other, the air vent block-moving step being performed during the second die-closing step;

a cavity sealing step for pressing the edge surface of the air vent block against a surface of a wiring board of the unsealed substrate in the substrate feeding portion to seal the cavity of the cavity block, the cavity sealing step being performed during the air vent block moving step;

a resin-molding step for further transferring the melted resin material under a pressure into the cavity to fill the cavity with the melted resin material, the resin-molding step being performed subsequent to the cavity-sealing step; and

a molded article-removing step for opening the stationary die and the movable die using the die opening/closing mechanism to remove a molded article solidified and molded in the cavity and the resin passage, the molded article-removing step being performed subsequent to the resin-molding step.

2. An apparatus for resin-sealing an electronic component, comprising:

dies for resin-sealing the electronic component, the dies having at least a stationary die and a movable die facing the stationary die, the movable die being allowed to move toward and away from the stationary die by a die opening/closing mechanism;

a cavity block disposed on a die surface of the stationary die in a manner that is allowed to move along a die opening/closing direction by a floating mechanism having an elastic member;

5 a cavity and an air vent groove connected to and communicating with the cavity and formed on a die surface of the cavity block;

a fit-in hole formed in a connected portion of the cavity and the air vent groove along the die opening/closing direction; and

10 an air vent block disposed on a portion of the stationary die corresponding to the fit-in hole along the die opening/closing direction, the air vent block being slidably and closely fitted in the fit-in hole.

3. An apparatus for resin-sealing an electronic component, comprising:

15 dies for resin-sealing the electronic component, the dies having at least a stationary die and a movable die facing the stationary die, the movable die being allowed to move toward and away from the stationary die by a die opening/closing mechanism;

a cull block and a first cavity block disposed on a die surface of the stationary die in a manner that are allowed to move along a die opening/closing direction by a floating mechanism having an elastic member;

20 a cull serving as a resin flow divider and disposed on a die surface of the cull block;

a gate connected to and communicating with the cull, a cavity connected to and communicating with the gate, and an air vent groove connected to and communicating with the cavity that are disposed on a die surface of the first cavity block;

25 a fit-in hole formed in a connected portion of the cavity and the air vent groove along the die opening/closing direction; and

an air vent block disposed on a portion of the stationary die corresponding to the fit-in hole along the die opening/closing direction, the air vent block being slidably and closely fitted in the fit-in hole;

30 a pot block having a resin feeding portion for feeding a resin material and disposed in a portion of the movable die facing the stationary die;

a side block disposed at a position on a lateral side of the pot block;

a second cavity block attached to a die surface of the side block, the second cavity block being allowed to move along the die opening/closing direction by a floating mechanism having an elastic member; and

5 an inter-die pressure-reducing mechanism for reducing a pressure in an inter-die space between the die surface of the stationary die and a die surface of the movable die during a first die-closing step for joining the die surfaces of the stationary die and the movable die using the die opening/closing mechanism, wherein

10 in a second die-closing step for pressing, in addition to the first die-closing step, the die surfaces of the stationary die and the movable die toward each other against elasticity of the floating mechanism using the die opening/closing mechanism, at least an edge surface of the air vent block arrives
15 the air vent block.